Announcements

- Homework for tomorrow…

  Ch. 26, Probs. 40

  Ch. 28, CQ. 4, Probs. 2 & 4

  CQ12: a) 2 b) ¼ c) 1

  26.16: $E = 1.1 \times 10^5$ N/C

  26.18: 25 nC

  26.22: 2.8×10^5 N/C

- Office hours…

  MW 10-11 am

  TR 9-10 am

  F 12-1 pm

- Tutorial Learning Center (TLC) hours:

  MTWR 8-6 pm

  F 8-11 am, 2-5 pm

  Su 1-5 pm

Chapter 28

The Electric Potential

(*Electric Potential Energy*)

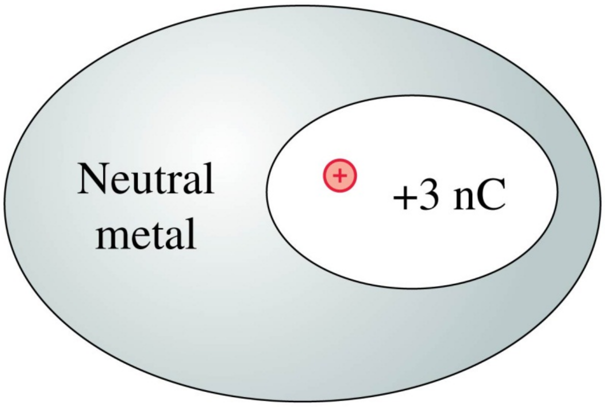
Last time…

Conductors in *electrostatic equilibrium*…

1. *E*-field is ZERO at all points w/in the conductor.
2. Any excess *q* resides on the *exterior surface*.
3. *E*-field at the surface of a charged conductor..
   - is *perpendicular* to the surface.
   - is of *magnitude* η/ε_o, where η is the surface charge density *at that pt*.
4. *E*-field is ZERO inside any hole w/in a conductor, *unless* there is a *q* in the hole.

Quiz Question 1

A +3 nC charge is in a hollow cavity inside a large chunk of metal that is electrically neutral. The total charge on the exterior surface of the metal is



1. 0 nC.
2. +3 nC.
3. -3 nC.
4. Can't say without knowing the shape and location of the hollow cavity.

Mechanical Energy Conservation

$$\boxed{E_{mech} = K_1 + U_1 = K_2 + U_2}$$

In any *isolated* system of objects interacting only through *conservative* forces, the total *mechanical energy* $E = K + U$, of the system, remains the same at all times.

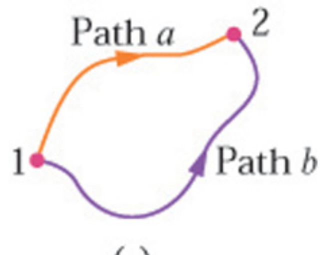
or

$$\boxed{\Delta E_{mech} = \Delta K + \Delta U = 0}$$

About *Conservative Forces*…

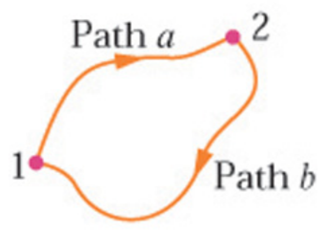
The work done by a *conservative force* on a particle

- is *path independent*.
- moving around any closed path is *zero*.



(*a*)

$$W_{1\to 2}^{path\quad a} + W_{2\to 1}^{path\quad b} = 0$$



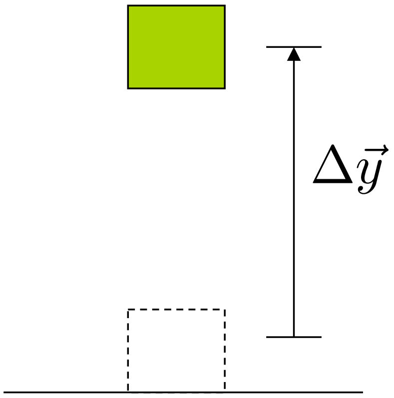
(*b*)

- The electric force is a *conservative force*.

Defining Potential Energy change…

The *change in potential energy* for a conservative system is defined as the *negative* of the internal work the system does on itself when it undergoes a reconfiguration.

$$\boxed{\Delta U \equiv -W}$$



- Potential energy is *stored work*!

Potential Energy cont..

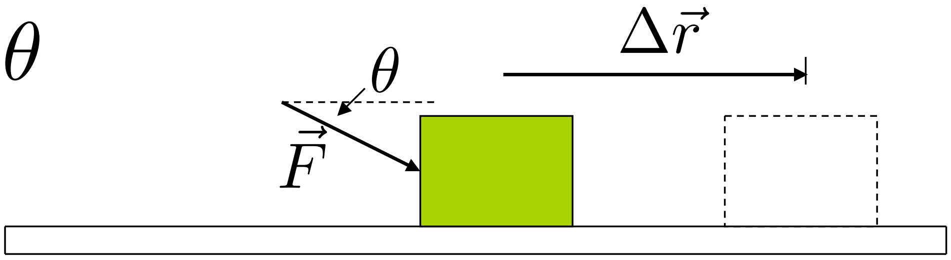
Notice:

- Potential energy is *stored* energy waiting to be ‘let loose’.
- Potential energy is a relative energy…
  The zero-reference level is arbitrary & must be chosen.
- Can only measure a *change* in P.E.

Work done by a *Constant Force*...

The *work* done by a *constant force* on a particle?

$$W = F\Delta r\cos\theta$$



in terms of the *dot product*

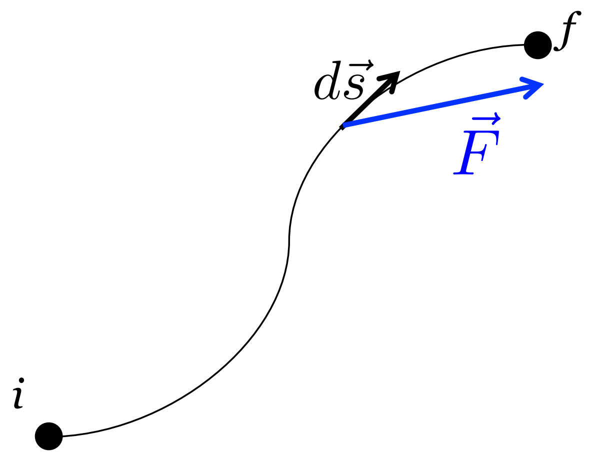
$$\boxed{W = \vec{F}\cdot\Delta\vec{r}}$$

- But what about a *variable force?*

Work done by a *Variable Force*...

The *work* done by a *variable force (or a variable path)* on a particle?

$$W = \int_i^f \vec{F} \cdot d\vec{s}$$



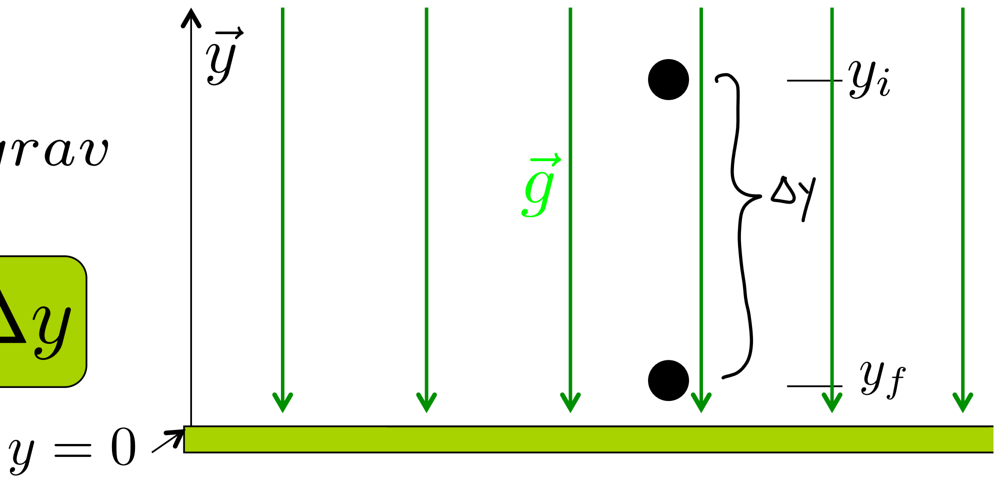
For a *uniform* *g*-field…

The *work done* on a particle of mass *m* falling in a *g*-field is…

$$W_{grav} = \vec{F} \cdot \Delta\vec{r}$$

$$W_{grav} = -\Delta U_{grav}$$

$$\boxed{\Delta U_{grav} = mg\Delta y}$$



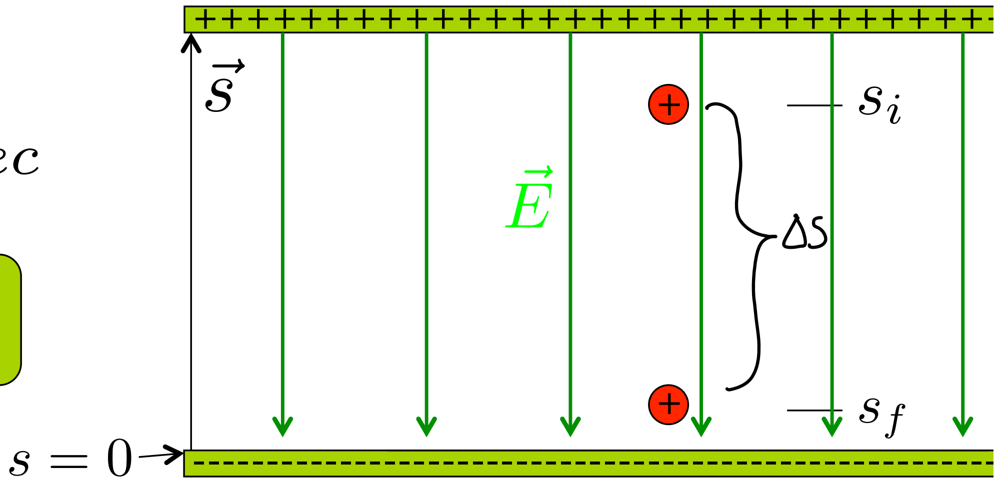
For a *uniform* *E*-field…

The *work done* on a particle of charge q 'falling' in an *E*-field is…

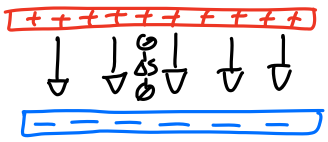
$$W_{elec} = \vec{F} \cdot \Delta\vec{r}$$

$$W_{elec} = -\Delta U_{elec}$$

$$\boxed{\Delta U_{elec} = qE\Delta s}$$



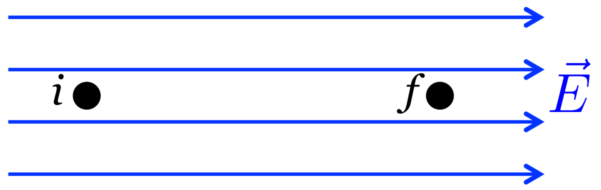
- But what about a *negative* charge?



$\Delta U_{elec} = QE\Delta S$

Quiz Question 2

An e^- moves from point i to point f, in the direction of a uniform E-field. During this displacement…



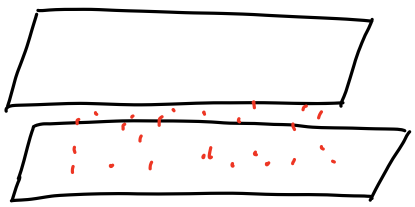
1. The work done by the field is *positive* and the potential energy of the electron-field system *increases*.
2. The work done by the field is *negative* and the potential energy of the electron-field system *increases*.
3. The work done by the field is *positive* and the potential energy of the electron-field system *decreases*.
4. The work done by the field is *negative* and the potential energy of the electron-field system *decreases*.
5. The work done by the field is *positive* and the potential energy of the electron-field system *does not change*.

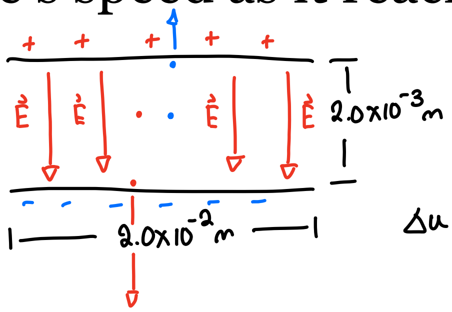
i.e. 28.1: Conservation of Energy

A 2.0 cm x 2.0 cm parallel-plate capacitor with a 2.0 mm spacing is charged to ± 1.0 nC. 1st a proton, then an electron are released from rest at the midpoint of the capacitor.

a. What is each particle's change in electric potential energy from its release until it collides with one of the plates?

b. What is each particle's speed as it reaches the plate?





$r = 1.0 \times 10^{-2}$ m

$d = 2.0 \times 10^{-3}$ m

$$\Delta u = \cancel{u_f} - u_i$$

$$\underset{0}{}$$

$$= -q\vec{E}\, d/2$$

$$0 = (K_2 - K_1) - qE\, d/2$$

$$= K_2 - qE\, d/2$$

$$= \tfrac{1}{2} m v_2^2 - qE\, d/2$$

$$v_2 = \sqrt{\frac{qEd}{m}}$$